

CLAIMS

1. A semiconductor wafer cleaning formulation for use in semiconductor fabrication comprising following components:
maleic acid, and
ethylene urea.
2. The cleaning formulation according to claim 1, wherein the formulation is an aqueous solution.
3. The cleaning formulation according to claim 2, comprising
1-9% by weight of maleic acid; and
1-20% by weight of ethylene urea.
4. The cleaning formulation according to claim 2, further comprising
at least one organic carboxylic acid except maleic acid, and
at least one organic amine except ethylene urea.
5. The cleaning formulation according to claim 4, comprising
1-9% by weight of maleic acid;
1-20% by weight of ethylene urea;
1-20% by weight of at least one organic carboxylic acid except maleic acid;
1-50% by weight of at least one organic amine except ethylene urea; and
20-70% by weight of water.
6. The cleaning formulation according to claim 4, wherein the organic carboxylic acid is selected from the group consisting of:
formic acid (FA),
acetic acid (AA), and
propionic acid (PA).
7. The cleaning formulation according to claim 4, wherein the organic amine is selected from the group consisting of:
hydroxyethylpiperazine (HEP),
hydroxypropylpiperazine (HPP),

aminoethylpiperazine (AEP),
aminopropylpiperazine (APP),
hydroxyethylmorpholine (HEM),
hydroxypropylmorpholine (HPM),
aminoethylmorpholine (AEM),
aminopropylmorpholine (APM),
triethanolamine (TEA),
pentamethyldiethylenetriamine (PMDETA),
dimethylaminoethoxyethanol (DMAEE),
aminoethoxyethanol (AEE),
trimethylaminoethylethanolamine (TMAEEA),
trimethylaminopropylethanolamine (TMAPEA),
N-(2-cyanoethyl)ethylenediamine (CEEDA), and
N-(2-cyanopropyl)ethylenediamine (CPEDA).

8. The cleaning formulation according to claim 4, further comprising at least one selected from the group consisting of:

an organic solvent,
a chelating agent, and
a surfactant.

9. The cleaning formulation according to claim 8, wherein the organic solvent, the chelating agent and the surfactant are contained in an amount by weight of 1-20%, 0.01-5% and 0.01-0.2%, respectively.

10. The cleaning formulation according to claim 8, wherein the organic solvent is selected from the group consisting of:

1,4-butanediol (1,4-BD),
1,3-butanediol (1,3-BD),
ethylene glycol (EG),
propylene glycol (PG),
N-methylpyrrolidone (NMP),
 γ -butyrolactone (GBL),
propylene glycol monomethylether (PGME), and
propylene glycol monomethylether acetate (PGMEA).

11. The cleaning formulation according to claim 8, wherein the chelating agent is selected from the group consisting of:
- ascorbic acid,
 - gluconic acid,
 - mannitol,
 - sorbitol, and
 - boric acid.
12. The cleaning formulation according to claim 8, wherein the surfactant is selected from the group consisting of:
- (C1-C10) alkyl glucosides.
13. A method for cleaning a wafer comprising:
- cleaning the wafer by using a chemical formulation including the following components:
 - maleic acid, and
 - ethylene urea.
14. The method according to claim 13, wherein the formulation is an aqueous solution.
15. The method according to claim 14, wherein the formulation comprises
- 1-9% by weight of maleic acid; and
 - 1-20% by weight of ethylene urea.
16. The method according to claim 14, wherein the formulation further comprises:
- at least one organic carboxylic acid except maleic acid, and
 - at least one organic amine except ethylene urea.
17. The method according to claim 16, wherein the formulation comprises:
- 1-9% by weight of maleic acid;
 - 1-20% by weight of ethylene urea;
 - 1-20% by weight of at least one organic carboxylic acid except maleic acid;
 - 1-50% by weight of at least one organic amine except ethylene urea; and

20-70% by weight of water.

18. The method according to claim 16, wherein the organic carboxylic acid is selected from the group consisting of:

formic acid (FA),
acetic acid (AA), and
propionic acid (PA).

19. The method according to claim 16, wherein the organic amine is selected from the group consisting of:

hydroxyethylpiperazine (HEP),
hydroxypropylpiperazine (HPP),
aminoethylpiperazine (AEP),
aminopropylpiperazine (APP),
hydroxyethylmorpholine (HEM),
hydroxypropylmorpholine (HPM),
aminoethylmorpholine (AEM),
aminopropylmorpholine (APM),
triethanolamine (TEA),
pentamethyldiethylenetriamine (PMDETA),
dimethylaminoethoxyethanol (DMAEE),
aminoethoxyethanol (AEE),
trimethylaminoethylethanolamine (TMAEEA),
trimethylaminopropylethanolamine (TMAPEA),
N-(2-cyanoethyl)ethylenediamine (CEEDA), and
N-(2-cyanopropyl)ethylenediamine (CEEDA).

20. The method according to claim 16, wherein the formulation further comprises at least one selected from the group consisting of:

an organic solvent,
a chelating agent, and
a surfactant.

21. The method according to claim 20, wherein the organic solvent, the chelating agent and the surfactant are contained in an amount by weight of 1-20%,

0.01-5% and 0.01-0.2%, respectively.

22. The method according to claim 20, wherein the organic solvent is selected from the group consisting of:

- 1,4-butanediol (1,4-BD),
- 1,3-butanediol (1,3-BD),
- ethylene glycol (EG),
- propylene glycol (PG),
- NMP,
- γ -butyrolactone (GBL),
- PGME, and
- PGMEA.

23. The method according to claim 20, wherein the chelating agent is selected from the group consisting of:

- ascorbic acid,
- gluconic acid,
- mannitol,
- sorbitol, and
- boric acid.

24. The method according to claim 20, wherein the surfactant is selected from the group consisting of:

- (C1-C10) alkyl glucosides.

25. The method according to claim 13, wherein the cleaning is carried out after a following process:

- (i) making via hole with etching and ashing process;
- (ii) making trench with etching and ashing process;
- (iii) punching of etch stopper layer; or
- (iv) CMP process after Cu deposition.